

We Claim:

1. A thermoplastic olefin composition, comprising:
  - a) a major amount by weight of
    - 1) a substantially linear homopolymer or copolymer of a C<sub>2</sub>-C<sub>10</sub>  $\alpha$ -olefin and
    - 2) a long chain branched a linear homopolymer or copolymer of a C<sub>2</sub>-C<sub>10</sub>  $\alpha$ -olefin,
  - b) a minor amount by weight of a cross linkable elastomer, and
  - c) at least one thermally decomposing free radical generating agent present in an amount sufficient to promote an increase in melt strength of the composition over that of the melt strength of the linear homopolymer or copolymer of a C<sub>2</sub>-C<sub>10</sub>  $\alpha$ -olefin alone and insufficient to substantially degrade the  $\alpha$ -olefinic polymers,wherein the composition is formed by melt blending the components at a temperature sufficient to melt said homopolymers or copolymers of a C<sub>2</sub>-C<sub>10</sub>  $\alpha$ -olefin and thermally decompose said agent.
2. The composition of claim 1 in which said agent is at least an azo compound of the general formula R<sub>1</sub>-N=N-R<sub>2</sub> in which R<sub>1</sub> and R<sub>2</sub> can be the same or different alkane groups.
3. The process of claim 1 in which said azo compound is present in an amount not exceeding about 1.0 phr of elastomer.
4. The process of claim 1 in which said azo compound is present in an amount less than about 0.5 phr of elastomer.
5. The composition of claim 2 in which said agent is an azoalkane.
6. The composition of claim 5 in which said azoalkane is selected from azosilanes, azonitriles, and  $\alpha$ -carbonyl azo compounds.

7. The composition of claim 5 in which said azoalkane is selected from the group consisting of 1-cyano-1-(t-butylazo) cyclohexane; 1-(tert-amylazo)-cyclohexanecarbonitrile; 1-(tert-butylazo)-cyclohexanecarbonitrile; 1-(tert-butylazo)-formamide; 1,1'-azo-bis(cyclohexanecarbonitrile); 1,1'-azo-bis-cyclohexane nitrile; 1,1'-azo-bis-cyclopentane nitrile; 2-(tert-butylazo) isobutyronitrile; 2-(tert-butylazo)-2,4-dimethylpentanenitrile; 2-(tert-butylazo)-2-methylbutanenitrile; 2-(tert-butylazo)-4-methoxy-2,4-dimethylpentanenitrile; 2,2'-azobis(2,4-dimethylpentanenitrile); 2,2'-azobis(2-acetoxypropane); 2,2'-azobis(2-ethylpropanimidamide).2HCl; 2,2'-azobis(2-methyl-butanenitrile); 2,2'-azobis(isobutyronitrile); 2,2'-azo-bis-methyl-2-methyl propionate; 2,2'-azo-bis-2-methylpropionitrile; 2,2'-azo-bis-cyclohexyl propionitrile; 2-cyano-2-propylazofornamide; 4-(tert-butylazo)-4-cyanopentanoic acid; 4,4'-azobis(4-cyanopentanoic acid); azo-bis-(N,N'-diethyleneisobutyramidine); azodicarbonamide; N,N'-dichloroazodicarbonamide; azo dicarboxylic acid diethyl ester; and azo bis (isobutyronitrile).
8. The composition of claim 5 in which said agent comprises a combination of an azo compound and an organic peroxide in which the amount of organic peroxide does not substantially exceed the amount of azo compound.
9. The process of claim 8 in which said organic peroxide is included in said composition in an amount not in excess of about 0.3 phr of said elastomer.
10. The composition of claim 1 in which said  $\alpha$ -olefin of said substantially linear homopolymer or copolymer of a C<sub>2</sub>-C<sub>10</sub>  $\alpha$ -olefin is at least propylene in major proportion.
11. The composition of claim 10 in which said  $\alpha$ -olefin of said long chain branched homopolymer or copolymer of a C<sub>2</sub>-C<sub>10</sub>  $\alpha$ -olefin is at least propylene in major proportion.
12. The composition of claim 1 in which said  $\alpha$ -olefin of said long chain branched homopolymer or copolymer of a C<sub>2</sub>-C<sub>10</sub>  $\alpha$ -olefin is propylene in major proportion.

13. The composition of claim 1 in which the elastomer comprises ethylene  $\alpha$ -olefin polymers.
14. The composition of claim 1 in which said elastomer comprises interpolymers and diene modified interpolymers, in either of which at least one monomer is ethylene.
15. The composition of claim 1 in which said elastomer is selected from polymers prepared by polymerizing ethylene with at least one C<sub>3</sub> -C<sub>20</sub> comonomer.
16. The composition of claim 1 in which said elastomer is selected from ethylene/propylene copolymers, ethylene/butylenes copolymers, ethylene/hexene-1 copolymers and ethylene/octene copolymers, ethylene/propylene/octene terpolymers, and terpolymers of ethylene, a C<sub>3</sub> -C<sub>20</sub>  $\alpha$ -olefin and a diene.
17. The composition of claim 1 in which said diene is dicyclopentadiene, 1,4-hexadiene, piperylene or 5-ethylidene-2-norbornene.
18. The composition of claim 1 in which said linear homopolymer or copolymer of a C<sub>2</sub>-C<sub>10</sub>  $\alpha$ -olefin is substantially linear polypropylene and said long chain branched homopolymer or copolymer of a C<sub>2</sub>-C<sub>10</sub>  $\alpha$ -olefin is long chain branched polypropylene.
19. The composition of claim 18 in which said substantially linear polypropylene is included in said composition in a majority proportion in relation to said long chain branched polypropylene.
20. The composition of claim 19 in which said substantially linear polypropylene is included in an amount from about 20 to about 85 weight percent, said long chain branched polypropylene is included in an amount from about 5 to about 20 weight percent and said elastomer is included in an amount from about 10 to less than a majority weight percent of the composition.
21. An article formed from the thermoplastic olefin of claim 1.
22. The article of claim 21 in which the article is thermoformed.

23. The article of claim 21 in which said thermoplastic olefin is extruded into a sheet and the article is thermoformed from said sheet.
24. An article formed from the thermoplastic olefin of claim 20.
25. The article of claim 24 in which the article is thermoformed.
26. The article of claim 25 in which said thermoplastic olefin is extruded into a sheet and the article is thermoformed from said sheet.
27. A thermoplastic composition, comprising from about 45 to 72 weight percent of substantially linear polypropylene; from about 8 to 15 weight percent of long chain branched polypropylene; from about 20 to 40 weight percent of cross linkable elastomer selected from ethylene/propylene copolymers, ethylene/butylenes copolymers, ethylene/hexene-1 copolymers and ethylene/octene copolymers, ethylene/propylene/octene terpolymers, and terpolymers of ethylene, a C<sub>3</sub>-C<sub>20</sub>  $\alpha$ -olefin and a diene; and from about 0.1 to about 1.0 phr of elastomer of at least one thermally decomposing free radical generating agent comprising an azoalkane compound, wherein said composition is formed by melt blending said components at a temperature above the decomposition temperature of said azoalkane.
28. The composition of claim 27 in which said azoalkane compound is selected from azosilanes, azonitriles, and  $\alpha$ -carbonyl azo compounds.
29. The composition of claim 27 in which said azoalkane is 1,1'-azobis(cyclohexanecarbonitrile).
30. An article prepared by thermoforming a sheet formed by extruding a thermoplastic olefin of claim 29.
31. Thermoplastic olefin compositions prepared by a process from components comprising:
  - a) from about 57 to about 72 percent by weight of substantially linear polypropylene,

- b) from about 8 to about 13 percent by weight of long chain branched polypropylene;
- c) from about 20 to about 30 percent by weight of an elastomer selected from EPDM and EPM elastomers; and
- d) from about 0.1 to about 1.0 phr of elastomer of weight of an azoalkane compound

said process comprising reacting the components in a melt under blending conditions at a temperature at least equal to the thermal decomposition temperature of the azoalkane compound.

- 32. An article prepared by thermoforming a sheet formed by extruding a thermoplastic olefin of claim 31.
- 33. A process of manufacturing a thermoplastic olefin, comprising:
  - a) providing a composition comprising
    - i) a major amount by weight of
      - A) a substantially linear homopolymer or copolymer of a C<sub>2</sub>-C<sub>10</sub>  $\alpha$ -olefin and
      - B) a long chain branched a linear homopolymer or copolymer of a C<sub>2</sub>-C<sub>10</sub>  $\alpha$ -olefin,
    - ii) a minor amount by weight of a cross linkable elastomer, and
    - iii) at least one thermally decomposing free radical generating agent present in an amount sufficient to promote an increase in melt strength of the composition over that of the melt strength of the linear homopolymer or copolymer of a C<sub>2</sub>-C<sub>10</sub>  $\alpha$ -olefin alone and insufficient to substantially degrade the  $\alpha$ -olefinic polymers, and
  - b) melt blending said composition at a temperature sufficient to melt said homopolymers or copolymers of a C<sub>2</sub>-C<sub>10</sub>  $\alpha$ -olefin and thermally decompose said free radical generating agent.

34. The process of claim 33 in which said agent is at least an azo compound of the general formula  $R_1-N=N-R_2$  in which  $R_1$  and  $R_2$  can be the same or different alkane groups.
35. The process of claim 34 in which in which said agent is an azoalkane.
36. The process of claim 35 in which said azoalkane is selected from azosilanes, azonitriles, and  $\alpha$ -carbonyl azo compounds.
37. The process of claim 33 in which said agent comprises a combination of an azo compound and an organic peroxide in which the amount of organic peroxide does not substantially exceed the amount of azo compound.
38. The process of claim 37 in which said organic peroxide is included in said composition in an amount not in excess of about 0.3 phr of said elastomer.
39. The process of claim 33 in which said  $\alpha$ -olefin of said substantially linear homopolymer or copolymer of a  $C_2$ - $C_{10}$   $\alpha$ -olefin is at least propylene in major proportion.
40. The process of claim 39 in which said  $\alpha$ -olefin of said long chain branched homopolymer or copolymer of a  $C_2$ - $C_{10}$   $\alpha$ -olefin is at least propylene in major proportion.
41. The process of claim 33 in which said  $\alpha$ -olefin of said long chain branched homopolymer or copolymer of a  $C_2$ - $C_{10}$   $\alpha$ -olefin is propylene in major proportion.
42. The process of claim 33 in which the elastomer comprises ethylene  $\alpha$ -olefin polymers.
43. The process of claim 33 in which said elastomer comprises interpolymers and diene modified interpolymers, in either of which at least one monomer is ethylene.
44. The process of claim 33 in which said elastomer is selected from polymers prepared by polymerizing ethylene with at least one  $C_3$  - $C_{20}$  comonomer.
45. The process of claim 33 in which said elastomer is selected from ethylene/propylene copolymers, ethylene/butylenes copolymers, ethylene/hexene-

1 copolymers and ethylene/octene copolymers, ethylene/propylene/octene terpolymers, and terpolymers of ethylene, a C<sub>3</sub>-C<sub>20</sub>  $\alpha$ -olefin and a diene.

46. The process of claim 33 in which said diene is dicyclopentadiene, 1,4-hexadiene, piperylene or 5-ethylidene-2-norbornene.
47. The process of claim 33 in which said linear homopolymer or copolymer of a C<sub>2</sub>-C<sub>10</sub>  $\alpha$ -olefin is substantially linear polypropylene and said long chain branched homopolymer or copolymer of a C<sub>2</sub>-C<sub>10</sub>  $\alpha$ -olefin is long chain branched polypropylene.
48. The process of claim 47 in which said substantially linear polypropylene is included in said process in a majority proportion in relation to said long chain branched polypropylene.
49. The process of claim 48 in which said substantially linear polypropylene is included in an amount from about 20 to about 85 weight percent, said long chain branched polypropylene is included in an amount from about 5 to about 20 weight percent and said elastomer is included in an amount from about 10 to less than a majority weight percent of the process.
50. The process of claim 49 in which said azo compound is present in an amount not exceeding about 1.0 phr of elastomer.
51. A process for forming an article from a thermoplastic olefin, comprising thermoforming a sheet extruded from a melt blended composition comprising
  - a) a major amount by weight of
    - i) a substantially linear homopolymer or copolymer of a C<sub>2</sub>-C<sub>10</sub>  $\alpha$ -olefin and
    - ii) a long chain branched a linear homopolymer or copolymer of a C<sub>2</sub>-C<sub>10</sub>  $\alpha$ -olefin,
  - b) a minor amount by weight of a cross linkable elastomer, and
  - c) when originally melt blended at least one thermally decomposing free radical generating agent included in an amount sufficient to promote an increase in

melt strength of the composition over that of the melt strength of the linear homopolymer or copolymer of a C2-C10  $\alpha$ -olefin alone and insufficient to substantially degrade the  $\alpha$ -olefinic polymers.